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ABSTRACT

Beginning with Western Kentucky University's (Bowling Green) fall 1999 semester, exercises required for the geography and meteorology course used computers for learning. This course enrolls about 250 students per year, most of whom choose it to fulfill a general education requirement. Of the 185 geography majors, it is required for those who choose the Meteorology-Climatology track. Prior to the use of computers, exercises required for the course were done using a locally written exercise manual. For the last few years, this manual has not existed and all the exercises are completed using computers with locally conceived, designed, written, and programmed exercises. Each exercise includes presentation of current and topical weather information, and real time meteorological data. An acquired program called, Test Pilot, performs the grading, record keeping, and immediate feedback to the students. All exercises are completed in the Meteorology Lab Room during scheduled times and under the supervision of Meteorology Lab instructors. The development/implementation of the computer exercises was fraught with problems. Time demands for this phase were unexpectedly and demandingly high. The subsequent years involved revisions, corrections, and reassessments. The exercises are now considered a normal and expected part of the course. This paper describes the course's evolution. It describes the learned techniques and procedures used in developing, implementing, and assessing this method of teaching meteorology. This application may be useful for those courses with enrollments too great for traditional laboratory exercises. The paper notes that these methods can be replicated for other physical geography courses. (Author/BT)

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COMPUTER EXERCISES IN METEOROLOGY

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Abstract

Beginning with the Fall Semester 1999, exercises required for Geography 121, Meteorology, have been completed using computers. At Western Kentucky University, this course enrolls about 250 students per year. Most of these students choose this course to fulfill a general education requirement. Of the 185 Geography Majors, it is a requirement for those who choose the Meteorology-Climatology Track. Prior to the use of computers, the exercises required for the course were done using a locally written Exercise Manual. For the last few years, no such manual has existed and all the exercises are done using computers and locally conceived, designed, written, and programmed exercises. Each exercise includes presentation of current and topical weather information, and "real time" meteorological data. An acquired program called Test Pilot performs the grading, record keeping, and immediate feedback to the students. All the exercises are completed in the Meteorology Lab Room during scheduled times and under the supervision of Meteorology Laboratory Instructors. The development and implementation of the computer exercises were fraught with problems. Time demands for this phase were unexpectedly and demandingly high. The subsequent years involved revisions, corrections, and reassessments. The exercises are now considered a normal and expected part of the course. That evolution will be presented in this paper. The learned techniques and procedures used in developing, implementing, and assessing this method of teaching meteorology will be described. Such application may be especially useful for those courses with enrollments too great for traditional laboratory exercises. These methods can be replicated for other physical geography courses.

The Department

The Department of Geography and Geology at Western Kentucky University, is a very active academic unit with 23 full time and part time faculty. The Geography component of the Department has a total of about 185 majors. There are 7 "Tracks" or areas of emphasis offered by the diverse faculty interests and expertise. Of the seven

tracks, the one entitled "Meteorology-Climatology Track" contains approximately 70 of the geography majors, and it is in within this track that this unique laboratory experience was developed.

There has been a weather station, the "College Heights Weather Station," on the Western Kentucky University's campus since 1928. Weather and climate courses have been offered in the Department of Geography and Geology since then. The meteorology courses offered have always had an associated laboratory component, and the manuals and materials used in the lab have always been developed in-house. There have always been Laboratory Assistants available for the implementation of these lab exercises. These Assistants have always been track majors and minors and always upper-division students. (These assignments have always been viewed as excellent learning and job experience for our advanced students.) In the mid 1970s the Office of the State Climatologist was established in the Department and shortly thereafter, the Meteorology/Climatology Track was developed along with a Meteorological Technology Associate Degree program. Both of these programs begin their sequence of courses with Geography 121, Meteorology.

GEOG 121, Meteorology

Geography 121 is the introductory course for all baccalaureate majors and minors in the Meteorology-Climatology Track and the Meteorological Technology Associate Degree program. For the campus at large this course is also offered for General Education credit as a Science Course with a Laboratory Component. This is a 3 credit hour course; 2 hours credit for the Lecture part and the additional hour for the Laboratory experience, but awarded just one grade.

There are 11 laboratory exercises altogether, one for each chapter assigned from the textbook. Each laboratory exercise focuses on the theme presented in the corresponding chapter. The laboratory materials have always been created in-house, i.e., the laboratory manual, any and all handouts, and any hands-on use of equipment.

Problems with the Old Paper Laboratory Manuals

The GEOG 121 laboratory experience has always taken place in our Laboratory Room, currently Room 425 in the Environmental Science and Technology Building. There are a number of reasons for this, the most important of which is security. The paper manuals were not to be taken home and used as homework assignments. They were not to be copied for use by next semester's students, nor were the answers designed to be shared by more than one student. Therefore students were to complete the laboratory exercises, within the laboratory room. The Laboratory Instructors were on duty to help students with any serious questions or problems. Further, the laboratory manuals had to be in our files so they could be periodically removed and graded.

For security purposes, each semester new questions were added to the exercises to assure that each semester's manual was significantly different from the previous manual. This created much work for professors who taught the course through the years.

Grading was much more difficult with the old paper manuals as well. The Laboratory Instructors were given a proper grading key for each page of the manual, with which they used a red pen to mark the wrong answers, and then sum the scores and for each exercise. Student answers were handwritten and required interpretation by the Instructor as to correctness. This procedure resulted in very slow feedback to the students. For example, students ready to work on Exercise 7 might still be waiting for their grade on Exercise 5.

Advantages of the New Computer Laboratory Exercises

There are several advantages to the new computer and web-based system of offering the GEOG 121 Laboratory Experience. Essentially there were no changes made to the number or the topical content of the 11 exercises. These new exercises are designed to stand-alone. By that we mean they can and do extend beyond the lecture material. Different faculty can use them, for different purposes. It is up to the faculty member of each section of the course to decide how much emphasis to place on the labs. For example one faculty member may place as much as 25% of the final course grade on the laboratory experience, while another faculty member may place 10% as the

contribution to the final grade. The exercises may help determine lecture content, or they may be viewed as totally ancillary to the material presented in class.

In each computer exercise, a variety of activities are to be performed. Through the "Activities Sections," students are directed to various web sites containing the information necessary to move forward. Each of these exercises has web sites that contain real-time meteorological data. For example the activity, which introduces students to the Skew-T Diagrams will show the most recent data collected at Nashville, Tennessee (our closest National Weather Service Station).

Once the 'bugs' were worked out of the programming, (completed in the first two years of operation), very few revisions were necessary. Revisions were usually to correct URLs that have been changed. As explained later, the quizzes, which appear in the "Questions Section," are randomly generated from a pool of questions written for each laboratory exercise. Thus eliminating the need to write new questions each semester.

The new computer labs also allow for instant grading, and feedback for the students. When the student submits his or her answers to the "Questions," a second later, the quiz reappears with the score and all the correct answers for the questions.

Laboratory Scheduling

For all intents and purposes the scheduling remains as it has always been. It is something we call an "open schedule." The Laboratory Room is open for approximately 20 to 22 hours per week. If the room is open, any student can go in and work. The students do not have to do their lab exercises at the same time each week. Their schedule is their choice within the schedule framework.

On the first day of classes, the students are polled for the best time during the week when they are free to work on the exercises. All the student choices are complied into a 'student preference schedule'. Then the Laboratory Instructors meet and try to fit as many of the preferred hours into their individual schedules. A team of 4 or 5 Instructors each working 4 or 5 hours per week can cover most of the busiest hours of the schedule. There is always an Instructor on when the Laboratory is open.

Infrastructure Changes

The actual laboratory room (EST Building 425) was not changed, but simply modified to handle the transition. The entire Meteorology Computer Laboratory is tied to the server in the Kentucky Climate Center (Office of the State Climatologist for Kentucky) one flight downstairs. It was necessary to install 12 Internet ports in the room: 1 for the Instructor's workstation, 1 for a printer, and 10 for individual student workstations. A National Science Foundation, Educational Equipment Grant, and a Perkins Educational Equipment Grant have allowed us to update the eleven Dell PCs, which comprise necessary equipment. Presently, our computer workstations consist of Dell models (Optiplex GX 260 Small Minitower Pentium 4 Processor, 2.40GHz, 533 FSB, 512K Cache, Intel Gigabit NIC).

Writing Procedure for the Laboratory Exercises

First of all, it essential for one to recognize that an undertaking of this type is very time consuming. It is difficult to estimate how many hundreds of person-hours were necessary to put these 11 exercises on line. Furthermore, computer programmer is absolutely necessary to write the appropriate commands in various languages. The exercise text and explanations (i.e., the meteorological parts) were all written in Microsoft Word word-processing software. Our computer programmer then wrapped the Word documentation in "Perl commands."

The control of the access of the Computer Exercises was through the selection of each computer's IP# address. This assured us that only the computer workstations in our laboratory room could have access to our exercises. Special access was given to all associated Faculty members and to the Laboratory Instructor's workstation.

The student passwords were used to check their 'progress along the way' in each exercise. In this way we were able to mandate that each student must complete each and every activity before they could be allowed to take the "Questions" at the end of the exercise. The student passwords also allowed for summing and recording each student's point scores for each exercise.

Test Pilot Component of the Exercises

Test Pilot is a software package for the creation and management of a massive bank of test questions. For our purposes, the test banks we wrote for the 11 exercises amounted to over 1200 available questions. Test Pilot randomly selects the questions for each quiz, while keeping the format of the quizzes the same. For example, if we wish each quiz for a particular exercise to contain, 5 Greenhouse Effect questions, 5 Ozone Hole questions, and 7 questions about the Composition of the Atmosphere. Then every quiz generated will contain this format. When students select the "Questions" at the end of the exercise, different quizzes will always appear. Students can work together on the exercise "Activities" however every quiz will be similar in appearance but with different questions. Test Pilot allows for other visuals like, weather maps, formulae, or instrument recording sheets to be incorporated into the various questions. These visuals are also randomized before they are incorporated into the questions.

As stated earlier, the "Questions" are instantly graded and returned to the student with the correct answers included. There are a variety of types of questions the Test Pilot program will accept. The types we use most often are: multiple choice, true/false, yes/no, completion, matching, formulae, and fill-in-the-blank.

Security is far more effective with the Test Pilot program. Students are allowed take the "Questions" (quizzes) more than once. The "Attempt Limits" option allows the faculty to decide how many attempts at the "Questions" he or she will allow. However with each attempt, a different quiz will appear. Students are warned, that we accept the last quiz score taken, so if they do worse on subsequent trials, they may end up with a lower point total. We usually set the limit at three attempts. "Time Limits" represents another option. The exercises can go on indefinitely, or can be cut off after a specified time. We usually set the "time limit" at 75 minutes. "No Earlier Than" and "No Later Than" dates and times can be set. In this way, your established schedule rules! The questions will not function before or after the set deadlines. More specific information concerning the Test Pilot program can be found at, [http://www.clearlearning.com].

Procedure for Completing the Laboratory

This section is designed to give you an idea of the procedure a student must follow to complete one of the 11 laboratory exercises. Again, all the exercises must be completed in the Laboratory Room on one of our workstations. There is always a Laboratory Instructor on duty to help with any questions, and to increase security.

Each student must log in the time and date, on their own personal Laboratory Grade Card. This cardboard grade card contains their name and lecture section number and a slot for each exercise point score.

The students then log into the Laboratory Exercises. Their login name is: first.last name (no capital letters, and no spaces). Their password is: the last 4 digits of their Social Security Number. Then the student uses a "drop box" to click on the desired Laboratory Exercise Number and Title. These are numbered 1 through 11.
When the appropriate laboratory exercise title page appears, the upper right-hand corner will display the number of points given for the completion of the "Activities." Since the "Activities" are mandatory, and require the performance of tasks or answers to questions, we allow 60% of the total point value to be given to the student upon their completion. There also appears the point value given for the "Questions" (quiz) at the end of the exercise. Therefore the student can see how many points are awarded for the successful completion of the "Activities" and a perfect score on the "Questions."

Next the student uses another "drop box" to click, one by one, through all the "Activities" listed. Again each "activity" is composed of hyperlinks to various active web sites for obtain information, read appropriate text, or work with real-time data. Only when each and every "Activity" has been completed, can the student click on the "Questions." At this point the Test Pilot program takes over and the student is tested on the material he or she should have learned from the "Activities." Afterward, the students are given their quiz score and the correct answers to the questions they missed.

Grade Comparison between the Old and New Laboratory Exercises

We wanted to see if there was any real difference in the laboratory grades earned by GEOG 121 students from the "old" paper manual labs and the "new" computer exercises. So a basic statistical comparison was run.

Four semesters worth of laboratory grades using the new computer approach were T-tested against the last four semesters grades using the old paper manuals. We only considered students earning an "A", "B" or "C" in the overall course grade. It is believed that, students earning a "D" or "F" in the course had likely skipped some of the laboratory exercises altogether, or did them very poorly.

"C" students tended to show no significant differences between the two methods of laboratory experience. However, the "A" and "B" students tended to score slightly but significantly higher with the "old" paper manuals then with the "new" computer approach. These results suggest that the new computer approach is more rigorous, but those grades were more reflective of the exam grades of these students. Therefore, we believe it is more accurate to say; the "old" paper manuals were perhaps a bit too easy.

Can grades reflect the true level of learning in our meteorology course? It is impossible to make that direct connection between the degree of learning and the level of the grade. However we strongly suspect that the richer, more diverse experience of the computer exercises does increase the student's learning.

Conclusions

For over a year, and with countless hours of design, research, writing and programming, the authors completed a set of 11 computer exercises, for GEOG 121, Meteorology Class. The new computer laboratory exercises, allow the student to explore a wide variety of web sites, and at the same time view and work with real-time meteorological data. This system uses two distinctively different realms of programming. One for the actual body of the exercise, and all the "Activities" the student must perform. The other encompasses the Test Pilot programming for the testing and scoring the student responses. It is believed that this approach to the "laboratory experience" allows for greater learning and understanding of the meteorological concepts presented in the class. It is also believed that this approach can be used for any introductory science course, which contains a laboratory component.

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